

## DESCRIPTION

### A METHOD OF ESTIMATING THE LOCATION OF A DEVICE

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This invention relates to a method of providing an estimate of the location of a device.

Recent progress in the field of GPS has enabled GPS receivers to be produced relatively cheaply leading to their widespread adoption and use. However, providing GPS receivers in all devices which might wish to utilise a location based service or execute a location based function may lead to many GPS receivers being required for which the cumulative costs may be prohibitive.

For example, consider a home networking environment in which is provided a mobile telephone with GPS capability for providing its location to a cellular telephone network operator in the event of an emergency call; a TV with GPS capability for providing TV access control, say as described in US patent 5621793; and a personal computer with GPS and Internet capability for retrieving location specific information from a web site, say a local weather report. In such a home networking environment, 3 GPS receivers would be required, each returning substantially the same location.

In addition, should one GPS receiver be unable to return a location fix, for example if it is defective or can not see enough satellites, the other nearby GPS receivers are unable to provide back up or assistance.

It is therefore an object of the present invention to provide an enhanced method of providing an estimate of the location of a device which obviates or at least mitigate these problems.

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In accordance with a first aspect of the present invention, there is provided a method of providing an estimate of the location of a first device

This would accommodate for a defective GPS receiver or a GPS receiver which was unable to acquire the GPS signals, say because of poor reception caused by signal obscuration in an urban environment.

Also provided in accordance with the present invention is combination  
5 of first and second separately housed devices according to claims 12 to 24;  
and a device according to claims 25 to 34.

Yet further provided in accordance with the present invention is a  
method of providing an estimate of the location of a first device using second  
and third devices as claimed in claims 36 to 39.

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The above and other features and advantages of the present invention  
will be apparent from the following description, by way of example, of an  
embodiment of a mobile cellular telephone comprising a GPS receiver for use  
in a cellular telephone network with reference to the accompanying drawings in  
15 which:

Figure 1 shows, schematically, two mobile units MS1, MS2  
according to the present invention;

Figure 2 shows, schematically, a mobile cellular telephone and a  
television according to the present invention; and

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Figure 3 shows, schematically, a mobile cellular telephone and a  
portable computer according to the present invention.

Referring to figure 1, two substantially identical mobile units MS1, MS2  
are shown, each comprising a communications transmitter (Comm Tx) and  
25 receiver (Comm Rx) 11 connected to a communications antenna 10 and  
controlled by a communications microprocessor (Comm  $\mu$ c) 12 for two-way  
Bluetooth communication.

In addition, each mobile unit MS1, MS2 further comprises a GPS  
receiver (GPS Rx) 14 connected to a GPS antenna 13 and controlled by a  
30 GPS microprocessor (GPS  $\mu$ c) 15 receiving GPS spread spectrum signals  
transmitted from orbiting GPS satellites. When operative, the GPS receiver 14  
may receive NAVSTAR SPS GPS signal through an antenna 13 and pre-

process them, typically by passive bandpass filtering in order to minimise out-of-band RF interference, preamplification, down conversion to an intermediate frequency (IF) and analog to digital conversion. The resultant, digitised IF signal remains modulated, still containing all the information from the available satellites, and is fed into a memory of the GPS microprocessor 15. The GPS signals may then be acquired and tracked for the purpose of deriving pseudorange information from which the location of the mobile telephone can be determined using conventional navigation algorithms. Such methods for GPS signal acquisition and tracking are well known, for example, see chapter 4 (GPS satellite signal characteristics) & chapter 5 (GPS satellite signal acquisition and tracking) of GPS Principles and Applications (Editor, Kaplan) ISBN 0-89006-793-7 Artech House. The GPS microprocessor 15 may be implemented in the form a general purpose microprocessor, optionally common with the communications microprocessor 12, or a microprocessor embedded in a GPS application specific integrated circuit (ASIC).

In the event that the GPS receiver and GPS microprocessor of MS2 is unable to acquire the GPS signals, for example due to obscuration in a urban environment, the mobile MS2 is unit broadcasts a request to RF receivers in the vicinity requesting that they respond by providing their location. In this case mobile unit MS1 which is able to determine its location replies sending its location whereupon the mobile unit MS2 receives the reply and uses the location determination of mobile unit MS1 as an estimate of its own location. Mobile unit MS1 may then convey this estimate to a user through a display. Where a short range RF communications link such as Bluetooth is used, it is possible to assume a reasonable degree of accuracy unless of course the location determination of MS1 is inaccurate.

A second example is shown schematically in figure 2 in which a GPS enabled mobile cellular telephone MS3 communicates with a television using a short range communications link, i.e. separate from the communications hardware required to communicate with base stations in a cellular telephone network. As with the mobile units of figure 1, a Bluetooth link would be appropriate.

The television and its integral receiver may use knowledge of its location to provide TV access control and to deter theft. For example, TV access control may be effected by receiving a location estimate from the nearby mobile telephone GPS receiver whereby only when the present location is consistent with an authorised location are the incoming video signals decrypted and displayed. However, rather than comprising its own GPS receiver, the television is provided with a wireless link to communicate with the nearby mobile cellular telephone from which it receives an estimate of its location based on the location determination of the GPS receiver in the mobile telephone.

A third example is shown schematically in figure 3 in which a NAVSTAR GPS enabled mobile cellular telephone MS3 is used with a laptop computer to remotely access using the Internet. When accessing web sites which provide location based services, the laptop requests from the mobile telephone its location which is transmitted to the laptop and then supplied to a web site server, back through the mobile telephone.

In order to reduce the time to first fix, the GPS receiver of such a mobile telephone may be provided with base station assistance in order to acquire GPS signals more quickly. Such assistance may include the provision by the base station to the receiver of a precision carrier frequency reference signal for calibrating the local oscillator used in the GPS receiver; the data message for up to date satellite almanac and ephemeris data from which Doppler shift for satellites in view can be determined; and the current PRN code phase. With such assistance, it is possible to sweep only a narrowed range of frequencies and code phases in which the target PRN code is known to occupy, thereby reducing the number of code instances that need to be checked and thus reducing the time for code acquisition. Base station assistance is further described in US patents 5841396 and 5874914 which are incorporated herein by reference.

At present GPS is most notably associated with the Navigation System with Time and Ranging (NAVSTAR) GPS, an all weather, spaced based navigation system developed and operated by the US Department of Defense,

however, the general principles underlying GPS are universal and not merely limited to NAVSTAR. Accordingly, GPS refers to any positioning system comprising a plurality of radio transmitters at different locations and a receiver which determines its location based on the time of arrival of the transmissions of the radio transmitters. In so far as a telephone is concerned, this would also include base station triangulation in which timing measurements were taken by the base stations and relayed back to the mobile telephone.

The invention is equally applicable to non-GPS location determining means such a fixed land based telephone having access to its subscriber address and hence location, or a traditionally fixed device such as a central heating controller which can be told its position, say from a nearby GPS enabled mobile telephone, and then store it for future dissemination.

From a reading of the present disclosure, other modifications will be apparent to the skilled person skilled and may involve other features which are already known in the design, manufacture and use of GPS receivers and component parts thereof and which may be used instead of or in addition to features already described herein. Although claims have been formulated in this application to particular combinations of features, it should be understood that the scope of the disclosure of the present application also includes any novel feature or any novel combination of features disclosed herein either explicitly or implicitly, whether or not it relates to the same invention as presently claimed in any claim and whether or not it mitigates any or all of the same problems as does the present invention. The applicants hereby give notice that new claims may be formulated to such features and/or combinations of such features during the prosecution of the present application or of any further application derived therefrom.